Remarks

The Office Action of March 24, 2005, has been received and considered by applicant and his attorney. In the Office Action, claims 1-6, 9-13, 17-21 and 23-26 were rejected as being anticipated by Steinmann. Claims 15 and 16 were rejected as being obvious in view of Steinmann. Claims 14 and 22 were rejected as being unpatentable over Steinmann in view of Bannan.

Claims 7, 8 and 27 were indicated as comprising allowable subject matter if re-written in independent form. By this amendment, claims 7 and 27 have been re-written in independent form, including all previously recited limitations. Claim 8, which depends from claim 7, is unchanged. As a result of these amendments, applicant submits that claims 7, 8 and 27 recite allowable subject matter in proper form.

In response to the Examiner's comments in the first Office Action, independent claims 1 and 18 have been amended to further distinguish applicant's claimed invention over the prior art. Also, new claims 28-34 have been added to recite important features of applicant's invention that also define patentably over the prior art. Claim 2 has been cancelled.

Claim 1, as presently amended, recites that the current to the solenoid assembly is adjusted by the electronic controller responsive to a comparison of the output voltage of the magnetic positioning sensor assembly and a known command electrical input signal. This forms an adjusting signal that alters the current transmitted to the solenoid assembly, positioning the valve element corresponding to the output voltage generated in proportion to the change in magnetic field. This amendment to claim 1 is found at paragraph 0042 of the specification, and therefore does not constitute new matter.

As amended, applicant submits that claim 1, as presently amended, is patentable over the applied Steinmann reference disclosure. The reference teaches a balanced solenoid valve that

utilizes a Hall-effect sensor to create voltage linearly from 0.5 volts to 4.5 volts relative to the stroke or displacement of the solenoid armature. The valve operating system disclosed at Fig. 16 of the Steinmann reference moves the valve between a full open to a full closed position. See: col. 24, ls. 59-67. The text of the reference patent, at col. 25, ls. 5-67, describes a system for calibrating the slope of displacement versus voltage output by using a voltage divider 782 to ultimately accommodate the interchangeability of valve assemblies 700. While the formula set forth at col. 25, ls. 44-47 of the reference takes into account the difference between a baseline voltage versus the voltage output of voltage divider 782, the reference does not teach a valve control system wherein a sensor output signal is compared to a known command electrical input signal to provide an adjusting signal, as specifically recited in claim 1, as amended, in a valve positioning feedback system.

Referring to Figs. 16-21, and col. 24, ln. 42 to col. 45, l. 18 of the Steinmann reference, the Hall-effect sensor 746 is calibrated prior to operation to produce a voltage output related linearly to the displacement of the solenoid armature. As will be explained, this teaching is contrary to the claimed function of the present invention. In the reference, the voltage generated by Hall-effect sensor 746 is transmitted to a voltage divider 782, which provides a conditioned output voltage. This output voltage is recorded versus the displacement of the solenoid armature in the reference device. Initially, with the S magnetic pole located adjacent the sensor, 0.5 volt is produced from the voltage divider. Current in solenoid coil 706 increases until armature 730 is near its maximum open position. The corresponding voltage output from voltage divider 782 is recorded against the sensed armature displacement. A linear relationship (Fig. 21) is established between sensor output voltage and armature displacement.

Applicant's claim 1, as amended, specifically recites that the current to applicant's valve solenoid is adjusted responsive to a comparison of sensor output voltage and a known command

electrical input signal. There is no such, or equivalent, comparison between sensor output voltage and a known command electrical input signal to provide an adjusting signal during calibration or operation of the reference device. In applicant's valve control system, the position of the valve element 44 can be adjusted, detected and utilized in an operational "feedback control" scheme, thereby allowing precise position control, velocity control, or force or pressure control of the fluid passing through valve assembly 26. The Hall-effect sensor of the reference device establishes a desired linear slope "m" for the reference valve control mechanism 700. The reference does not teach or suggest the comparison function of the structure set forth in applicant's claim 1, as amended. Therefore, claim 1 is submitted as allowable over the Steinmann reference.

Claims 1-6 and 9-17 all depend from claim 1, or from claims that ultimately depend from claim 1, and are submitted as allowable for the reasons set forth above in support of the allowance of claim 1.

Claim 18, as presently amended, recites inter alia, a valve operating mechanism, a magnetic positioning sensor assembly providing a magnetic field responsive to the position of the valve element, a control system controlling linear movement of the valve element responsive to an electrical signal generated in proportion to the change in the magnetic field detected by the sensor, and the electrical signal being compared to a known command electrical input signal to form an adjusting signal having a value proportional to the change in the magnetic field, the adjusting signal altering the control system and positioning the valve corresponding to the adjusting signal. Thus, the combination of applicant's elements, and their related functions as recited in claim 18, provides proportional positioning of the valve element, incorporating a feedback system for precise positioning of the valve assembly proportional to the change in magnetic field. Applicant's claimed invention does not merely move the solenoid armature to

"near the maximum open position" as recited at col. 24, l. 66 to col. 25, l. 4 of the Steinmann reference.

The differences between the invention set forth in claim 18 and the valve control of the Steinmann reference are substantial and not obvious, in that the voltage divider 782 of the reference is not described at col. 24, l. 30 to col. 25, l. 67 of the reference as providing a comparison between a change in the flux field detected by the Hall-effect sensor 746 and a known command electrical input signal, to provide an adjusting signal proportional to the change in the magnetic field and use that adjusting signal to position the valve element corresponding to the adjusting signal. The description of the function of the voltage divider 782 of the reference does not form a teaching or suggestion of the subject matter of claim 18. Therefore, claim 18, as amended, is submitted as allowable over the Steinmann reference.

Claims 19-26 all depend either directly or indirectly from claim 18, and are submitted as allowable for the reasons set forth above in support of the patentability of claim 18.

New claim 28 is directed to applicant's inventive embodiment of the present invention where the first and second portions of the proportional directional control valve are separable, and each portion includes replaceable electrical connections between the electronic controller and the valve assembly when the first and second portions are joined together. The combination recited in new claim 28 does not constitute new matter. The separability of the first and second portions of the control valve are described at page 5, par. 0007, last three lines and at page 22, par. 0048. No new search is required since the subject matter of new claim 28 is also partially recited in previously submitted claim 5. Applicant submits that neither the Steinmann nor Barman references teach or suggest the separability structure or function in the combination of proportional valve elements set forth in new claim 28. Therefore, new claim 28 is submitted as allowable.

New claim 29 depends from claim 28, and is submitted as allowable for the above reasons supporting the allowance of claim 28.

New claims 30-34 depend from claim 1, directly or indirectly. Claim 30 recites that the valve of claim 1 comprises two axially arrayed, linearly moveable valve elements, while claims 31-34 related to the calibration of the magnetic positioning sensor in combination with the two solenoid assemblies. As reflected in new claims 31-34, applicant's magnetic positioning sensor is calibrated by aligning output voltages of the sensor with a center position of the valve element, a full shift position of the first solenoid assembly and a full shift position of the second solenoid assembly, all with known command electrical input signal values embedded in the electronic controller (claims 32 and 34). The relationship between the output voltage of applicant's sensor and the position of the valve element is <u>different</u> between (a) the center position and full shift position of the first solenoid assembly, and (b) the center position and full shift position of the second solenoid assembly (claim 33).

The relationship between output sensor voltage and valve position according to the teaching of claim 33 is illustrated on the chart attached as Exhibit A to this response. The chart depicts valve displacement readings plotted against sensor voltage output. Applicant's calibration does not utilize offsets to the sensor output, compared to the slope offset and conditioning illustrated in Figs. 19 and 21 of the Steinmann reference, and the text material describing the reference device's operation at col. 25, ls. 25-67.

In applicant's claimed device, referring to Exhibit A, the electronic controller will find three points: maximum position 1 with the first solenoid energized, maximum position 2 with the second solenoid energized, and centerline position 3. By using these readings, the slope of the sensor output is different from points 1 to 3 compared to the slope of sensor output from 2 to 3. In the chart, a linear line (dotted) is interposed to show that the sensor output in applicant's

device is not linear from points 1 to 2. By using a center value, the offsets or "curve fitting" taught by the Steinmann reference is avoided in applicant's claimed device. For these reasons, and the reasons given above in support of the allowability of claim 1, new claims 30-34 are submitted as allowable.

Conclusion

For the above-stated reasons, applicant submits that claims 1 and 3-34, as presently amended, are allowable over the applied references.

Respectfully submitted,

Howard B. Rockman

Howard B. Rockman
Reg. No. 22,190

Customer No. 23642
BARNES & THORNBURG LLP
One North Wacker Drive, Suite 4400
Chicago, IL 60606
Tel.: (312) 214-4812
Fax: (312) 759-5646
Email: hrockman@btlaw.com